THURSDAY, MAY 10, 1877

MATHEMATICS IN AMERICA

Elements of the Differential and Integral Calculus, by a new Method, founded on the True System of Sir Isaac Newton, without the Use of Infinitesimals or Limits. By C. P. Buckingham. (Chicago: S. C. Griggs and Co., 1875. 343 pp.)

Elements of the Infinitesimal Calculus, with Numerous Examples and Applications to Analysis and Geometry. By James G. Clark, A.M. (Ray Series. New York: Wilson, Hinkle, and Co., 1875. 441 pp.)

On a New Method of Obtaining the Differentials of Functions with Especial Reference to the Newtonian Conception of Rates or Velocities. By J. Minot Rice and W. Woolsey Johnson. (New York: D. van Nosbrand, 1875. 32 pp.)

AN American writer who had exceptional opportunities of contrasting the methods of mathematical teaching adopted in his own country with those which obtained at Cambridge twenty-five years ago, strongly condemns the Transatlantic system, and leads his readers to infer that the attainments of the ordinary graduate in this particular branch of study were only on a par with those of a fairly trained schoolboy here. It may be supposed, then, that not many of the students ventured upon the difficulties of the calculus. Indeed, he writes that "at Yale where the course used to be thought a very difficult and thorough one, the Differential was among the *optional* studies at the end of the third year." (Bristed: "Five Years at an English University," vol. ii, pp. 94, &c., 1852.)

We are not in a position to say that all this has been changed in the interim, but among many evidences of the increased interest taken in mathematical studies we may surely refer to the three works now before us. All three give evidence of careful study and honestly grapple with the difficulties which beset the learner at the very threshold of his inquiries. De Morgan long ago wrote that "it is matter of common observation that any one who commences the study, even with the best elementary works, finds himself in the dark as to the real meaning of the processes which he learns, until, at a certain stage of his progress, depending upon his capacity, some accidental combination of his own ideas throws light upon the subject." The authors of the third work under review refer to D'Alembert's precept, "Allez en avant, et la foi vous viendra."

Mr. Buckingham takes as his fundamental idea of the conditions under which quantity may exist to be that we must not consider it only as *capable* of being increased or diminished, but also as being actually in a *state of change*. "It must (so to speak) be *vitalised*, so that it shall be endowed with *tendencies* to change its value; and the rate and direction of these tendencies will be found to constitute the groundwork of the whole system. The differential calculus is the SCIENCE OF RATES, and its peculiar subject is QUANTITY IN A STATE OF CHANGE."

Conceding to Leibnitz the honour of being the first to construct a system of rules for the *analytical machinery* of the science, he will not allow that he ever got beyond the ancient conception of the conditions of quantity. "The only original birthplace of the fundamental idea of quantity which forms the true germ of the calculus was in the mind of the immortal Newton."

An introduction of thirty-six pages discusses the method of Descartes, the infinitesimal method (the results of which are true, while the method is false—"true results *not* because its principles are true, nor because its errors are small, but because they are, whether great or small, exactly equal, and *exactly cancel and destroy each other*. . . . the system is but a mere artifice."), the method of limits (here our author discusses Lemma I., Book I. of the "Principia," considers Newton's defence of the Lemma, and the opinions of Comte, Lagrange, and Berkeley, and points out what he believes to be the fundamental errors of this method and of the infinitesimal method). What is called the true method of Newton is then treated of. Referring to Newton's letter to J. Collins (December 10, 1672), he says that the theory on which Newton formed *his* method of fluxions is contained in the second Lemma. The lemma is given in full and discussed. "It is to be remarked that the doctrine of *limits* is nowhere hinted at, but the results are direct, positive, and substantial." We cannot tarry longer over this matter, but in connection with this point refer to De Morgan's "On the Early History of Infinitesimals in England" (*Phil. Mag.* November 1852). Prof. Clifford, too, if our recollection of an oral communication be correct, puts this lemma prominently forward in his (? unpublished) "Foundations of the Differential Calculus and of Dynamics." In the work itself we have the calculi (differential and integral) applied to the subjects which usually find a place in similar treatises. There is an appendix of thirteen pages on geometrical fluxions. Many examples are worked out, but the merit of the work does not lie at all, we think, in this direction, but altogether in the numerous discussions which are to be found in almost every chapter.

Mr. Clark's work has been exceedingly well printed, the type is very clear, and the paper good. This treatise, too, is written with a view to remove "all grounds for that feeling of uncertainty which often possesses the student at the very outset, and from which he rarely finds it possible to extricate himself." Much space is given to an exposition of the Doctrine of Limits—the work being founded mainly on that by Duhamel. A large number of examples have been taken from English treatises (Hall, Walton, and Todhunter). Rather more ground is covered in this treatise than in the former; in neither, however, have we any discussion of maxima and minima of functions of more than two independent variables, nor of methods of changing the variables in multiple integrals. Here a few pages are devoted to definite integrals and to differentiation and integration under the sign $\int$. Seven chapters are devoted to the elementary parts of the theory of differential equations. The work, though it does not reach the level of the like works by Messrs. Todhunter and Williamson, is yet a compact and fair elementary treatise.

The third work on our list is a revised edition of a paper read before the American Academy of Arts and Sciences, January 14, 1873. It is the authors' intention

to publish a text-book in accordance with the plan adopted in this pamphlet. The objects are, "first to present a new method of deriving the differentials of functions by means of their algebraic characteristics with the aid of a few elementary properties easily established, and secondly to show that the method of rates or fluxions may be advantageously used for the purposes of instruction, and the use of infinitesimals, limits, and series entirely avoided until the student is well grounded in the elements of the calculus."

The first seven articles under the head "the Newtonian Method of Fluxions," treat of the methods in general use at the present time, and contain extracts from Todhunter, Lacroix, Carnot, and Cournot, especially directing attention to the positive advantages of the Newtonian method, as set forth by the last-named writer. The next six articles are occupied with the "Proposed Method of treating the Differential Calculus."

The remaining half of the pamphlet is given to algebraic and transcendental functions. It would be very interesting to lay before our readers an account of the ingenious methods adopted by our authors, but it would take up too much space. Some idea of the original paper (and there are no great differences, we fancy, between the two publications) can be got from an account of it furnished by Mr. J. W. L. Glaisher, F.R.S., in vol. iv. (pp. 58-64) of the *Messenger of Mathematics* (1875).

Altogether, on a review of the three books before us, we anticipate that mathematical studies are destined to occupy a more prominent position in the American colleges and schools than they have in the past.[1]

R. TUCKER

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.]

Visibility of the Ultra-Violet Rays of the Spectrum

It is well known how surprisingly rich in rays of high refrangibility the spectrum of the electric arc formed between carbon points is, above that of all other artificial flames; and also how far beyond the ordinarily discernible rays of the solar spectrum, formed by a glass prism, light may be traced by eyes carefully shielded, and raised to the highest susceptibility to perceive it. The name of "lavender-grey" rays has been given to them from a colour of that tint which they are considered to possess, but the term "ultra-violet," which is more commonly used, betrays perhaps a lingering doubt as to the sensible existence of another order of coloured rays in the spectrum distinct from the violet and superior to it in refrangibility, which has yet been detected by very close and careful observation. All doubts of this kind, which from want of sufficient acquaintance with that part of the spectrum I have myself been hitherto rather too prone to entertain, have lately been quite dispelled by frequent observations of the spectrum of the electric arc between carbon points thrown by a quartz prism on a white paper screen. The violet end of the spectrum terminates rather abruptly, or at least beams with bright colour that fades off very quickly; and in the dark space beyond it three more refrangible bright bands are visible with more or less distinctness. The middle one of the three is the brightest, and from its perfect freedom from colour, in which it contrasts most remarkably with the strongly-tinted light-belt near it, and its distant separation from the violet termination of the continuous spectrum, I at first hastily ascribed it to a "ghost," or faint image of the slit, indirectly refracted and reflected through the prism, and thrown with the spectrum on the screen. That it is not so, however, is shown by the action of these three lines on fluorescent substances, of all of which that I have tried they excite the fluorescence most strongly, especially that of fluorescin, eosin, rose of Magdala, and other solutions, all of which alike show these rays to be clearly defined and well-insulated spectral bands. In particular, the solutions of æsculin, paviin and amido-terephthalic acid are only excited by these "ultra-violet" lines, and not by any rays in the spectrum of lower refrangibilities, clearly showing that the vigorous fluorescence that they produce is not the effect of any ordinary light-beam of common refrangibility, irregularly transmitted by the prism, but that they are well-marked rays, probably of carbon, in the spectrum of the voltaic arc. The light of the middle band is bright enough to be easily reflected and examined separately from the rest of the spectrum on a white screen, where it is so nearly grey or colourless that it scarcely admits of being ranged in any colour scale, although the name "lavender-grey" perhaps expresses better than any other term the faintest possible tone of colour which, if it exhibits any at all, this almost purely neutral, or steel-grey band of rays may possibly be suspected to possess. It is a little more strongly absorbed by ordinary plate-glass than the neighbouring violet bands; but it remains visible in the spectrum of the arc formed by an ordinary flint glass prism, though much spread out and enfeebled by the dispersion, which greatly exceeds that of a quartz prism of the same refracting angle. It is perhaps for this reason that it is not perceptible in the spectrum of the arc as usually projected on a screen with a fluid-prism of bisulphide of carbon, but if the latter is replaced by benzine, which disperses the light less than flint glass, it forms a pretty conspicuous grey band in the spectrum. The other two lines or bands are so much fainter than the principal one, that in general they can only be found with the help of a fluorescent substance, and where so faintly visible it is not possible to speak positively as to their colour. The less refrangible is very near the violet termination of the spectrum, and when well seen it shares its violet tinge; the more refrangible one is nearly as far beyond the principal grey band as this band is beyond the margin of the violet, and as far as its weak light allows one to distinguish, it is of the same colour as the brightest band. In order to determine their positions, some measurements were made of metallic lines, and of the spectra of sodium, lithium, thallium, and strontium in the arc, with the result that the violet part of the continuous spectrum extends to the closely-neighbouring positions of the hydrogen line $H\delta$ (h), the potassium flame-spectrum line $K\beta$, and the last violet line in the arc spectrum of a salt of strontium. The first faint outlying ray occupies nearly the position of H_1 in the solar spectrum, and it is therefore in the true violet region of the spectrum, as its colour faintly indicates. The prominent grey line begins with its brightest edge about as much further beyond this, from the end of the violet field; and becoming weaker from there, it is about twice as broad as the distance between the two Fraunhofer lines H, its mean position in the spectrum being nearly as far from H as H is from h, reckoning the distances as they would be seen with the quartz prism and with solar light. The third faint line occurs about as far again from the violet as this band; and it lies at least as far beyond H as the distance between G and H in the solar spectrum. Yet it is visible there by glimpses, like the first faint member of the group, which it does not yet by any means surpass in the strength with which it produces fluorescence.

If any fresh proof was needed of the characteristic grey appearance of visible rays in this portion of the spectrum it was soon presented in one of the metallic spectra used to determine their positions. The spectrum of mercury exhibited a bright line (beautifully distinct when a fluid prism of benzine was used with a refracting angle of between 50° and 60°), much brighter than the principal grey carbon band, considerably more refrangible, and of the same tintless, and perfectly neutral grey appearance. Though not so distant from the violet as the most refrangible faint carbon line, it is yet according to the best measurements and identifications that were made, about as far beyond H_1 in a prismatic spectrum as H_1 is from G; and radiation of this high degree of refrangibility is evidently strongly luminous, when sufficiently intense, with homogeneous grey light characteristic of this region, and contrasting conspicuously in its appearance with the zone of violet colour, which often borders closely upon it in electric spectra.

[1] We are confirmed in our views on this subject by a perusal of Dr. Sylvester's characteristic address at the Johns Hopkins University on Commemoration Day, February 22, 1877.

The wave-lengths of the bands, and other positions in the spectrum, roughly obtained, by which it may be possible to identify some of them in photographic spectra, although open to some uncertainty from the inconstant length and strength of the arc of flame in the electric lamp, which confused and shifted some of the comparison lines, were as follows :—

Electric Arc with Carbon Poles.	Wave-lengths.
End of the violet field (*h*, Kβ, and last violet line in arc-spectrum of strontium, 4,080–4,100)	About 4,100.
First light-band ; faint violet-grey (H_1, 3,968 ; H_2, 3,933)	About 4,000–3,950.
Second do., strong grey band	About from 3,900 to 3,800.
(Strong grey line of mercury	About 3,700).
Third do., faint, grey	Between 3,600 and 3,500 (?).

Other metallic arc-spectra probably present lines in this portion of the spectrum, of which it would be interesting to examine the apparent brightness and the colours. At present the most conspicuous that I have met with is the grey line of mercury, which is brighter and more refrangible than the grey band of the electric light between carbon points. Its very advanced position in the spectrum, and the absence, or negative appearance of colour in its pretty bright light, both taken together seem to indicate very clearly that the grey or "lavender-grey" division of the spectrum fully equals in extent, when seen prismatically, the violet, the indigo, the blue, or any of its other better known, and much more ordinarily visible companion regions, the seven Newtonian colour-spaces of the spectrum. A. S. HERSCHEL

College of Science, Newcastle-on-Tyne, April 26

Pele's Hair

I HAVE read with great interest Mr. Moseley's description of Pele's Hair in NATURE (vol. xv., p. 547), since it furnishes information which I was most anxious to obtain. It seemed to me extremely probable that the analogy between Pele's Hair and the artificial furnace products would not be confined to the long fibres, and I did my best to ascertain whether irregular glassy spherules occurred along with the natural products. I was unable to obtain specimens for examination, but paid a visit to my friend Mr. J. G. Sawkins, F.G.S., who had explored the crater and collected the hair, in order to ask him whether he had ever noticed the pear-shaped spherules. He told me that he had never seen anything but the glassy fibres. I must say that I felt very much inclined to believe that the specimens usually collected are the material which has been blown some distance by the wind, consisting of the fibres from which most of the spherules have been broken. Mr. Moseley's letter in NATURE, and another which he has kindly addressed to me, make me believe that the analogy between the artificial and natural products is more complete than I was able to ascertain before Mr. Moseley's observations were published. In conclusion I would say that these facts in no way invalidate my arguments in respect to meteorites. They merely show that in certain cases the glassy volcanic spray, like melted furnace-slag, can to some extent collect into more or less imperfect spherules, so far analogous to those in meteorites as to indicate how those remarkable bodies were formed, but these spherules are accompanied by many fibres, which I have never yet seen in meteorites. This difference appears manifestly to depend on the difference in the temperature of the space into which the glassy spray was thrown. If the temperature of the air in the crater of Kilauea were equal to that of the melting point of the lava, we should almost certainly find, as in meteorites, many spherules and no hairs. H. C. SORBY

The Critical Point of Carbonic Anhydride

As the writer is not aware that any attempts have hitherto been made by others to exhibit to a large class the phenomena attending the passage through the critical point of a liquid in the presence of its gas, he is of opinion that the following account of a method which he has found very successful may be of interest :—

Dr. Andrews's apparatus for the study of gases was employed in the experiments, and the image of the tube containing the carbonic anhydride was projected on a screen by means of the oxy-hydrogen lime-light and a solar microscope which magnified it about 120 diameters. Dr. Andrews's apparatus consists of a thermometer tube filled with carbonic anhydride and a second tube filled with dry air, which serves to measure the pressure applied. The lower ends of these tubes dip beneath the surfaces of mercury contained in test-tubes, which are suspended in strong copper cylinders communicating with each other, and filled with water, which presses on the mercury in the test-tubes. The pressure is applied by means of long steel screws which pass through the bottoms of the cylinders. For the filling and mounting of these tubes the University of Cambridge is indebted to the kindness of Dr. Andrews. The lantern was supported on three screws, which allowed it to be raised or lowered so as to bring any required portion of the thermometer tube into the field of view of the microscope. The best height for the lantern was found to be such that the top of the tube was rather less than half an inch above the axis of the microscope. When the oxygen was turned on, the radiation from the lime cylinder raised the temperature of the portion of the tube within the field of view above the critical point in little more than a minute, so that no other source of heat was required ; but when the oxygen was turned off the tube cooled through several degrees.

The best method of performing the experiment is as follows :— The lantern having been properly adjusted, the gas should be lighted, the oxygen turned on, pressure applied until the surface of the mercury comes into the field of view and the microscope focussed so as to give a distinct image of this surface. The pressure should then be relieved and a blast of cold air from a bellows or gas bag directed against the tube. This will cool it considerably below the critical point. The pressure should then be increased, the cold blast being continued until the inverted image of the concave surface of the liquid reaches the middle of the field of view appearing as a broad dark line possessing considerable curvature, and, of course, concave downwards. The focussing screw should now be finally adjusted so as to give the best image of this surface, and the blast then stopped. Immediately after cutting off the blast the operator must obtain command over one of the screws and carefully increase the pressure as the temperature rises so as to keep the image of the liquid surface just above the centre of the picture on the screen. As the temperature and pressure increase the broad image of the surface becomes narrower and less concave until, as the temperature approaches the critical point, the line becomes very thin and faint and loses its curvature altogether ; it then seems to explode into mist and vanish as the critical point is reached. Another half turn of the screw then produces the well-known clouds or flickerings, which are best seen on the screen somewhat below the middle of the field, and in a few more seconds all is steady. More pressure should then be applied until the mercury reaches the axis of the microscope, but no change of state will be manifested by the carbonic anhydride.

It is important that the image of the surface of the liquid should not be below the centre of the field of view on the screen, for if the liquid stand in the tube above the axis of the microscope, since the greatest heat is there concentrated, bubbles of gas are liable to be formed within the liquid and to damage the continuity of the surface. Perhaps the flickerings may be due to unequal temperatures at different parts of the tube, so that some are just above and others just below the critical point. The mode of propagation of a sound wave through a substance just at the critical point may be an interesting subject for inquiry.

After passing the critical point the blast of air should be directed against the tube for about a minute. This will, of course, cause the image of the mercury to descend upon the screen, but no change of state will appear to take place in the carbonic anhydride. The pressure should then be rapidly diminished by turning the screws, when a violent ebullition will be seen, showing that the whole of the contents of the tube had assumed the liquid state during the cooling, the gas having passed at the critical point into the liquid without breach of continuity, so that no indication of a change of state was apparent on the screen. On increasing the pressure and continuing the blast the liquid surface will again appear, and the experiment can be at once repeated. WM. GARNETT

Cavendish Laboratory, Cambridge

Floating Cast Iron

HAVING read the interesting letter on this subject which appeared in NATURE (vol. xv., p. 529), I send the following copy of notes of experiments which I made about three years ago.

Several pieces of pig iron were put into a ladle (holding about one ton of metal); these at *first sank*, and a rush of hot metal took place upwards; after a few seconds the pieces of pig iron appeared *floating, with very little of their bulk* above the surface of the molten metal. A piece of flattish metal of irregular shape floated with a small portion alone of its corners above the surface; it was close to side of ladle. Pieces of flat cast-iron bars, 20″ × 2″ × 1″, were carefully placed on surface (the latter being well skimmed); they floated without going below the surface. One of these pieces, which was put in *end on*, kept in this position for a few seconds, with its upper end above the surface; the other end then came up and floated on its flat side. In some cases a sharp crack was heard when the metals touched, and a white flame on one occasion burned like a gas jet from the side of one of the pieces.

The surface of the molten metal was in constant motion due to the currents within its mass, and showed the variegated texture or "break" peculiar to this condition of the metal. From notes of an experiment which I arranged for, but did not see carried out, I find that a cast-iron ball of about $2\frac{3}{4}''$ diameter, when lowered by a fine wire upon a well-skimmed surface of molten cast iron, *disappeared completely* at first, and then in a few seconds rose and floated with about half an inch diameter of surface exposed; it was then raised from the metal, when it showed a red glow on the lower part. It was again lowered, but now *did not sink*, but floated with about *twice* the surface exposed, as on the first experiment.

Different views are held as to the behaviour of cast iron when passing from the molten to the hot solid state, and finally to the cold (or ordinary temperature) state.

Some hold that the molten metal, on solidifying, expands like water passing into ice, and that it retains this expansion to such an extent that the cold solid is specifically *lighter* than the molten metal. Others hold that no such expansion takes place, and that finally the cold solid is specifically *heavier* than the molten metal. A third view is that the molten metal on solidifying *expands*, and that it then *contracts* during cooling, until it reaches ordinary temperature, when through the cooling it is specifically *heavier* than in the molten state.

From the fact that in foundry practice the linear contraction is taken at $\frac{1}{96}$th part, there can be little doubt that the finally cooled solid is specifically *heavier* than the molten metal; again, from the sharpness of form of iron castings and other circumstances, expansion appears to take place on solidification.

The above experiments, I think, favour this latter view, as the floating took place more readily with small than with large pieces, partly due to their relative bulks and surfaces.

A probable explanation, in part at least of these phenomena, I think, is that the cold metal, when at first put in, is specifically *heavier* than the molten metal, but owing to the great heat around it (over 2,000° F.) it is rapidly heated, and consequently *expanded*, and when sufficient volume has thus been obtained it floats. It is evident that small pieces, being more readily heated, may remain floating, whilst heavy pieces, whose volumes are larger in proportion to their surfaces, will take longer to heat, so as to induce the required change of volume, and may therefore at first sink, remaining below the surface till sufficiently expanded to rise and float. The experiment with the ball bears out this well, as, being a sphere, its surface was a minimum.

These experiments appear to corroborate very well those of your correspondent.

The following experiments which I lately made with lead may be of interest:—

An ingot of lead of 14 lbs. weight was placed on the surface of about 160 lbs. of molten lead; it at once melted. After allowing the metal to cool a little, an ingot was carefully placed on the surface, when it immediately sank, bubbles rising up to the surface; it was heard to strike the bottom of the ladle. Another ingot was tried; it also sank, and could be felt at the bottom (these ingots were cast from the lead in the pot). A small solid piece was cast of about $1\frac{1}{2}$ lb. weight, which also sank. Pieces of *sheet lead* were rolled up and placed on surface; these *floated*: the contained air and great surface in the latter would account for this.

These latter experiments with lead correspond very well with those of your correspondent with zinc. W. J. MILLAR

Glasgow

Yellow Crocuses

IN my garden the sparrows do not touch the crocuses that of a friend, some miles off, they attack the yellow ones exclusively. I address you chiefly to report a fact related to me by the vicar of a neighbouring parish, whose garden is infested with mice. He tells me that for some time he thought he could not grow crocuses at all, as the mice destroyed the corms, discovering and digging down to them, even when there was no trace of the plants on the surface. At last he found that they did not attack the purple crocus, and on his planting the edge of a long border, with alternate clumps of yellow and purple crocuses, the mice almost entirely destroyed all the clumps of yellow, but left the purple untouched. Possibly the purple plant possesses some acrid or bitter taste, rendering it nauseous to animals—the corms to mice, the flowers to sparrows and other birds.

Newton-le-Willows, May 4 THOMAS COMBER

Hog-Wallows and Prairie Mounds

IF Mr. Williams is right, and the "hog-wallows" are simply American cousins of our "eshars" or "kames," is it not reasonable to credit that "atmospheric erosion" to which Prof. Le Conte attributes the formation of the former with a much more important influence upon the shapes of the latter than British geologists generally seem disposed to accord to it? It is very difficult to conceive that mounds of loose sand and gravel, whether in valleys or on plains, should have retained the impress of the glacier or the iceberg throughout the vast time that must have elapsed since these phenomena entirely disappeared. And if it be conceded that these mounds have been modified in any degree by subaërial denudation, it will be found difficult to limit the extent to which they are indebted to it for their present forms, or indeed to deny that it alone may have shaped them.

Newport, Fife, May 7 JAS. DURHAM

A "Golden Bough"

IN the gardens of New College, Oxford, there is a fine avenue of horse-chestnut trees, most of which have had some of their lower limbs lopped off, followed by the usual crop of abundant smaller shoots around the original bough. In one tree, however, with respect to one severed branch, these resultant shoots bear, year after year, not green, but pale yellow leaves, the summer through—

"Primo avulso non deficit alter
aureus, et simili frondescit virga metallo."

It would be interesting to know of other instances of such a veritable "golden bough," and whether any explanation can be given of chlorophyll so remarkably failing to develop its blue-green constituent under no obviously peculiar circumstances. It seems a strange a[illegible]aly to find an apparent case of host and saprophyte in one. HENRY T. WHARTON

SPONTANEOUS GENERATION

ON Friday evening last the Rev. W. H. Dallinger made an important communication to the members of the Royal Institution on "Recent Researches into the Origin and Development of Minute and Lowly Life-forms; with a Glance at the Bearing of these on the Origin of Bacteria." Biological Science to-day presents us with a magnificent generalisation; and that which lies within it and forms the fibre of its fabric, is the establishment of a continuity—an unbroken chain of unity—running from the base to the apex of the entire organic series. But does this imposing continuity find its terminus on the fringe and border of the organic series, and for ever pause there? or, can we see it pushing its way down and onward into the unorganised and the not-living, until all nature is an unbroken sequence and a continuous whole? That such a sublime continuity may be philosophically hypothecated is to be believed. But that data have been presented to us demonstrating how and by what path the inorganic passes to the vital, the living into the not-living, may be denied. The properties of living matter distinguish it absolutely from all other kinds of things, and the facts to-day in the hands of the biologist furnish us with no link between the living and the not-living. This is an inference which has been fiercely disputed.

But what are the nature of the proofs relied upon to establish the "spontaneous" or not living origin of living things? They were chiefly thermal experiments upon the lowest septic organisms, without an attempt to discover what was their life history, and whether they propagated by germs or not. It was argued that the adult organisms being killed at a given temperature much below the boiling point of water, if an infusion were boiled with every possible precaution, and whilst boiling her-

metically sealed, and after a lapse of time on opening the vessel the organisms were found in a living state, they must have arisen *de novo*. That is, the not living would have produced the living; that this method is useful, and that it must be pursued in an exhaustive inquiry into the whole subject, must be freely admitted. But that it is the best, or at least the only, method of inquiry for the biologist we may gravely doubt.

Ten years ago Mr. Dallinger determined to endeavour to work out by actual microscopic observation the life history of some of the lowly life forms.

After four years spent in preparation he commenced his work in conjunction with Dr. Drysdale, the plan needing two observers. A characteristic feature of the work was that each set of observations should be made absolutely continuous, so that nothing should have to be inferred. An arrangement was made by which the little drop of septic fluid containing the objects under examination should be free from evaporation, and very high powers were employed. The largest adult objects included in the examination were the one-thousandth of an inch, the smallest adults were the four-thousandth. Six forms altogether were selected, and, by long, patient, and unbroken watching, their whole history was worked out. While reproduction by fission seemed at first to the observers to be the usual method, prolonged research made known that spores were produced. These were so small that a magnifying power of 5,000 diameters was needed to see them as they began to grow. The glairy fluid from which they developed seemed at first homogeneous, and it was only when growth set in that the spores became visible. All that could be learnt about the origin of the glairy fluid was that a monad, larger than usual, and with a granulated aspect towards the flagellate end, would seize on one in the ordinary condition. The two would swim about together till the larger absorbed the smaller, and the two were fused together. A motionless spheroidal glossy speck was then all that could be seen. This speck was found to be a sac, and after remaining still for from ten to thirty-six hours it burst, and the glairy homogeneous fluid flowed out. The young spores that came into view in this were watched through to the adult condition. Bearing on the subject of spontaneous generation, this fact was learnt, that while a temperature of 140° F. was sufficient to cause the death of adults, the spores were able to grow even after having been heated to 300° F. for ten minutes. Can it be philosophical, Mr. Dallinger asked, with the life history of bacteria still unknown, to assume it as a different method of propagation? Some experiments based on Prof. Tyndall's use of the electric beam to test optically pure air were made. The remains of infusions known to contain certain spores were diffused through glass tubes, in which were placed vessels with fluid. Monads always appeared in the fluids, but when after the air in the tubes had been allowed to purify itself by settlement, fresh fluids were introduced, no monads appeared. That there is no such thing as spontaneous generation of monads seems quite clear, and when bacteria are in like manner studied, there can be hardly a doubt the same law will be found to hold good with them.

GREAT GUNS

IT is natural that at the present time great interest should be taken in all efforts to improve, that is, to render more destructive, our implements of war. Even since the last war on the European field great advances have been made in this direction; and, as our readers know, one of the largest guns ever constructed is at present on its trial in this country. Some months ago experiments were made with what is known as the 81-ton gun, the invention of Mr. Robert Fraser; the gun was sent back to Woolwich for some alterations to be made, and on Friday the experiments were resumed at Shoeburyness on a larger scale. On the previous occasion the gun was loaded with 370 lbs. of powder, and threw a blind Palliser shell against the target. This target is of enormous strength, as strong and firmly founded as the ingenuity of engineers can make it. It is formed of four plates of the best rolled iron, each plate being 8 inches thick, and 5 inches of solid teak filled up each of the three intervals between the four plates. The 32 inches of iron and 15 inches of teak thus placed are solidly screwed together by bolts 3 inches in diameter, the whole forming, as far as scientific engineers and artillerists could construct it, an apparently impenetrable and immovable mass. To secure the target still more, iron plates were placed on the top and at the side, those at the side being strutted against the target with heavy timbers; and the supports at the rear of the target, to hold it up, as it were, against any blow, were of the like solid and substantial character.

The target stood at 120 yards' distance from the gun. On Friday the charge of powder was 425 lbs., and the weight of the blind Palliser shell 1,700 lbs. At the base of the latter was an expanding copper-ridge, known as the "Lyon" gas-check, which in the explosion would expand and fill the rifling, thus enabling the full energy of the exploded powder to be utilised.

After the gun was fired, by electricity, it was examined and found to have worked admirably; it had run back 55 feet on its tramway, which rises slightly, and had run down again to the firing-point. The shot was found not only to have penetrated three plates and the teak intervals to all four, as on the previous occasion, but to have bulged out the fourth plate some 15 inches from its normal position. The last plate was, moreover, broken across, the edges of the broken part gaping wide, and showing the head of the shot, which had thus penetrated further in distance than the 47 inches of iron and teak of the target. The powerful framework behind the target was greatly shaken. The shot itself had "set-up," *i.e.*, closed towards the head with the enormous energy, the rear-part, the gun-metal studs, and the copper gas-check, crumbling into pieces. The initial velocity of the shot, as registered by M. Le Boulenger's invention of wires with electric communication was 1,500 feet a second, and the striking velocity 1,585 feet. The mean pressure on the gun was found to be 20 tons, the interior remaining quite unaltered.

Herr Krupp, the well-known Prussian artillerist, has been devising a weapon even more formidable than that whose power of destruction was shown on Friday to be so immense. The Fraser gun is of wrought iron, but the new Krupp gun is of cast-steel, both being very nearly of the same weight, though the latter has the great advantage over the former of being a breech-loader. The length of the gun, including the breech-piece, is 29 feet 6 inches, the breech-piece itself being 6 feet 4 inches in length. The calibre of the gun is 15¾ inches. The weight of the projectile will be 750 kilogrammes, or 1,650 lbs., and the powder charge will be 396 lbs. The external diameter of the Krupp gun, independently of a narrow strengthening ring at the extreme rear, is 5 feet 10 inches, that of the Fraser gun being 6 feet. The core of the Krupp gun is a steel tube in two lengths, upon which four steel rings overlap, rising in steps from a point between the muzzle and the trunnions, and accumulating in the thickness towards its rear. These more massive rings are irrespective of the narrow strengthening ring over the powder chamber. The external diameter of the gun at the muzzle is 2 feet 3½ inches.

In common with the other large Krupp guns, the rifling of the new weapon is on the polygroove system, the elongated projectile being rotated by means of the gas-check. The velocity anticipated from the projectile fired from the Krupp 80-ton gun is 473 metres per second at the muzzle, or 1,552 feet, producing an energy of 27,543 foot tons, equal to 556 foot tons per inch of shot's circumference.

But this is not all. Should the demand arise, the great Prussian gun-maker has a design already prepared for a gun of 124 tons, to be made on the same plan as the one just described. The larger weapon would have a calibre slightly exceeding 18 inches, and would throw a steel shell weighing 1,000 kilogrammes, or a chilled iron shell of 1,030 kilogrammes. The weight of the projectile would therefore be practically a ton, and the charge of powder will be probably about 500 pounds.

SUSPECTED RELATIONS BETWEEN THE SUN AND THE EARTH[1]

II.

IN my last article I endeavoured to show that as a matter of fact there is an intimate connection between the physical state of the sun's surface and the diurnal range of the magnet freely suspended at the Kew Observatory. It was suggested that this relation might be that of cause and effect, inasmuch as the variations of spotted area exhibited in Diagram B invariably precede the corresponding variations of magnetic range.

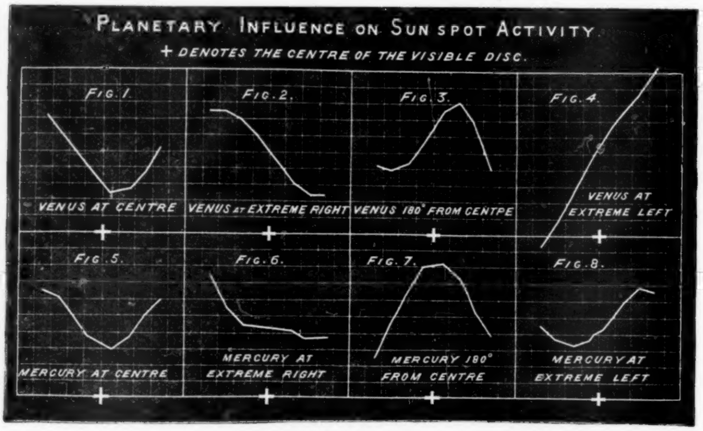

DIAGRAM C.

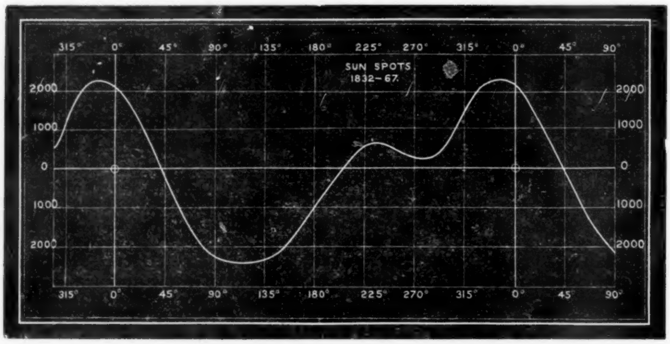

DIAGRAM D.

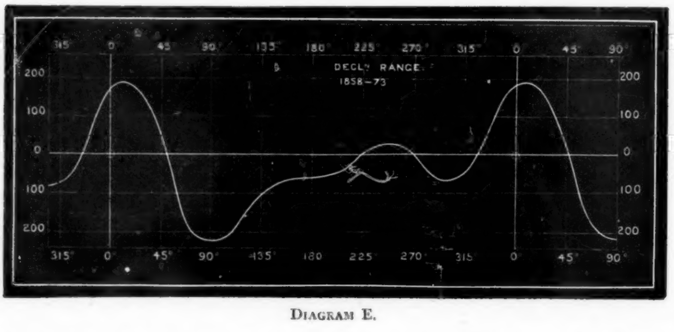

DIAGRAM E.

It cannot, however, with propriety be said that sun spots are the cause of magnetic oscillations, for it has been pointed out by Mr. J. A. Broun that even when there are no spots on the solar surface the magnet has yet a very considerable range in its daily oscillations. Then, on the other hand, the spectroscopic researches of Mr. J. N. Lockyer and others leave us little room for doubting that there may be vast solar activity without sun-spots, while, however, spots will probably make their appearance when the disturbance of the sun's surface is very great.

In fine, sun-spots will probably only afford us a rough means of estimating solar activity just as rainfall might give us a rough means of estimating the meteorological activity of a district of the earth. Is it not possible that sun-spots are in truth a species of celestial rainfall?

Be this as it may, it is evident that, inasmuch as sun-spots exhibit a recurring period, we are entitled to say there is a period of this kind in the meteorology of the sun. The interesting question then arises, What can be the possible cause of such a period? This question has been discussed by Mr. Warren De La Rue and those associated with him in his solar researches.

The theory propounded by these observers is that the planets are in some unknown way concerned in the production of spots. In their paper, which will be found in the *Proceedings* of the Royal Society for March, 1872, they make the following remark:—

"It might be said, 'How can a comparatively small body like one of the planets so far away from the sun cause such enormous disturbances of the sun's surface as we know sun-spots to be?' It ought, however, we think, to be borne in mind that in sun-spots we have, *as a matter of fact*, a set of phenomena curiously restricted to certain solar latitudes, within which, however, they vary according to some complicated periodical law, and presenting also periodical variations in their frequency of a strangely complicated nature. Now these phenomena must either be caused by something within the sun's surface, or by something without it. But if we cannot easily imagine bodies so distant as the planets to produce such large effects, we have equal difficulty in imagining anything beneath the sun's surface that could give rise to phenomena of such a complicated periodicity. Nevertheless, as we have remarked, sun-spots do exist, and obey complicated laws, whether they be caused by something within or something without the sun. Under these circumstances, it does not appear to us unphilosophical to see whether as a matter of fact the behaviour of sun-spots has any reference to planetary positions. There likewise appears to be this advantage in establishing a connection of any kind between the behaviour of sun-spots and the

[1] Continued from p. 11.

positions of some one prominent planet, that we at once expect a similar result in the case of another planet of nearly equal prominence, and are thus led to use our idea as a working hypothesis."

Proceeding upon this principle, these observers measured every sun-spot recorded by Mr. Carrington from the beginning of 1854 to the end of 1860, as well as every one photographed at the Kew Observatory from the beginning of 1862 to the beginning of 1867, and the results of all these measurements are recorded in Diagram C.

In this diagram each curved line is supposed to represent the behaviour, as regards size, of the various groups of spots as they pass across the disc of the sun by solar rotation from left to right. If, for instance, a spot were always to retain the same magnitude, its path would be represented by a horizontal line, but if it were to become smaller at the middle of its course than at either extremity, then we should have it represented as in the first figure. Now, from this diagram, we find that whenever either Venus or Mercury is between or nearly between our earth and the centre of the sun, the sun-spots behave as in the first figure; that is to say, as they are carried round by rotation nearer to the planet, they become less, and as they are carried away from the planet they become greater. Secondly, when Venus or Mercury is at the extreme right of the sun the spots diminish in size all the way across. Thirdly, when Venus or Mercury is on the other side of the sun, exactly opposite the earth, the spots have their maximum in the centre; and, finally, if Venus or Mercury be at the extreme left, the spots augment in size all the way across; in fine, they are always least in the immediate neighbourhood of Venus or Mercury, and greatest when that portion of the sun to which they are attached is carried by rotation to the position farthest from the influential planet.

If there be any truth in this evidence it would seem to follow as a corollary that when two influential planets are together on one side of the sun, their peculiar spot-producing action should be conspicuously great, and hence there should be a greater than usual amount of spots when such conjunctions take place.

On the other hand, when one influential planet is on one side of the sun and another on the other side, they might be supposed to counteract each other, and hence the spotted area would be conspicuously small. In a memoir which will be found in the *Transactions* of the Royal Society for 1870 the Kew observers have

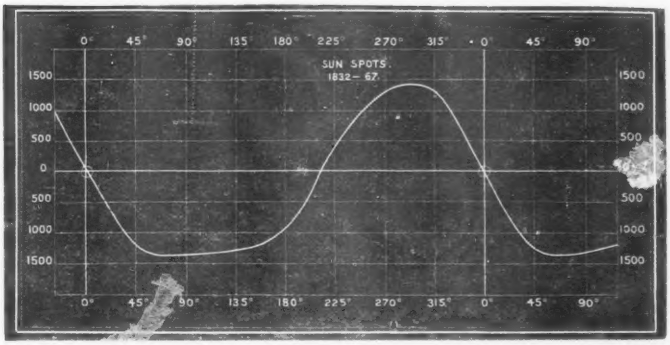

DIAGRAM F.

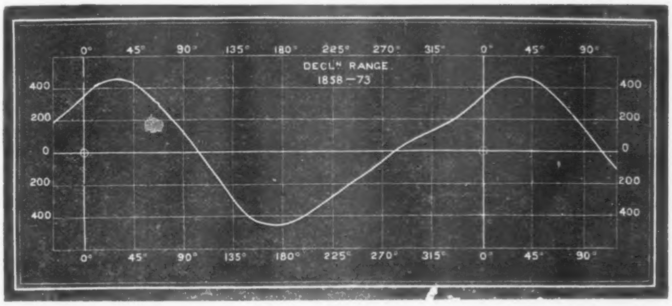

DIAGRAM G.

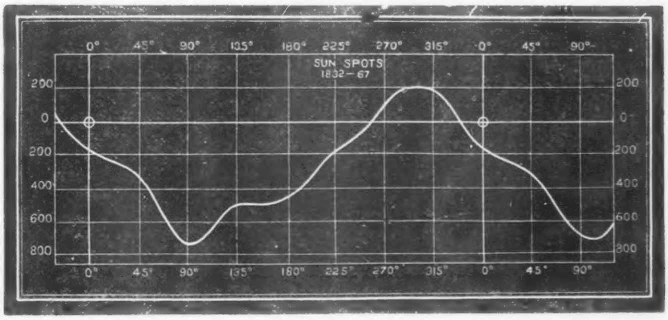

DIAGRAM H.

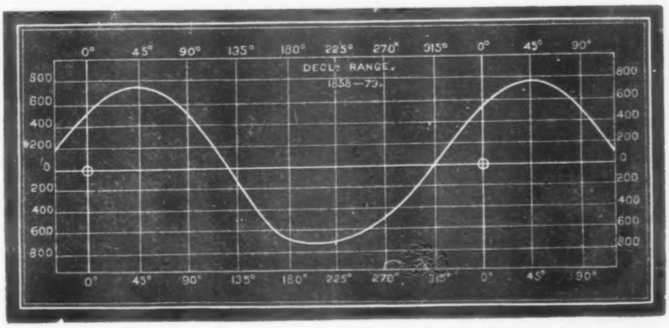

DIAGRAM I.

investigated this point also, and they appear to have found sun-spot inequalities depending on the relative positions of the various influential planets.

For instance, there is a greater than usual amount of sun-spots when Venus and Jupiter are together; there is the same a little before the time when either Venus and Mercury or Mercury and Jupiter are together, and finally, there is the same a little before the time when Mercury is nearest the sun.

These results of strictly solar observation are capable of being verified in quite a different manner. If the planets have an influence on the sun and if the state of the sun's surface affects terrestrial magnetism, it might be expected that we should have magnetic inequalities depending upon the positions of the planets.

By this it is not meant that the planets influence the magnetism of the earth directly, but rather through their effect upon the solar surface.

Again, it was shown in the last article that terrestrial magnetic effects at Kew lag behind corresponding states of the solar surface. This lagging behind ought therefore to be exhibited in any comparison which we make between sun-spot inequalities depending on the planets and magnetic inequalities at Kew depending on the same cause *if the latter inequalities are caused indirectly through the medium of the sun.*

A comparison of this kind has recently been made by the writer, using for this purpose those inequalities of short period that were most likely to be exhibited in the limited series of magnetic observations at his disposal for the purpose.

The results are embodied in the preceding diagrams. Diagram D represents the sun-spot, and diagram E the magnetic inequality due to the relative positions of Mercury and Venus (0° denoting conjunction). Diagram F represents the sun-spot, and diagram G the magnetic inequality due to the varying distance of Mercury from the sun (0° denoting perihelion). Diagram H represents the sun-spot, and diagram I the magnetic inequality due to the relative positions of Mercury and Jupiter (0° denoting conjunction). From all these it will be seen that there is a striking likeness in character between the planetary sun-spot inequalities, and the planetary magnetic inequalities derived from the records of the Kew Observatory—the latter, however, lagging behind the former in point of time, as might have been expected.

It is unquestionably a very strange and striking conclusion that the daily range of the magnet freely suspended in a vault of the Kew Observatory, should be sensibly greater about the times when Venus and Mercury, or Venus and Jupiter come together in position, and also about the times when Mercury is nearest the sun.

Perhaps it is not too much to say that the facts described in the last article go to show that the sun influences the earth, and possibly also the other planets in some unaccountable manner, while the facts of this article go to show that (shall we say in return) the most conspicuous planets of the system, and possibly also the earth, are not without an influence upon the state of the solar surface. I may be permitted, in conclusion, to transcribe a paragraph from a former essay on this subject (Owens College essays). "At first sight we are startled by the supposition that a planet like Venus, which comes nearer to the earth than it ever does to the sun, should in any way be accountable for such enormous manifestations of energy as those which occur over the sun's surface. But the wonder will disappear if we bear in mind that there may be two kinds of causes or antecedents. Thus we may say that the blacksmith is the cause of the blow with which his hammer strikes the anvil, and here the strength of the blow depends upon the strength of the smith. But we may likewise say that the man who pulls the trigger of a gun or cannon is the cause of the motion of the ball, and here there is no relation between the strength of the effect and that of its cause.

"Now, in whatever mysterious way Venus and Mercury affect the sun, we may be sure it is not after the fashion of the blacksmith—they do not deal him a violent blow producing all this enormous effect, but they rather pull the trigger, and immediately a very great change takes place." BALFOUR STEWART

(*To be continued.*)

THE NEW ZOOLOGICAL GARDENS AT CALCUTTA

THE propriety of establishing Zoological Gardens at Calcutta, has, as those who are acquainted with the proceedings of the Asiatic Society of Bengal are well aware, been before the public and the Indian Government for these last fifty years. It is, however, only within a very recent period that anything has been practically effected, and the first report on the progress made in the development of the new institution during the first year of its existence has only just reached us. Before alluding to its contents, a few words on the origin of the present scheme may be acceptable to those who take an interest in the subject.

Many previous plans for the institution of Zoological Gardens in Calcutta, including that proposed by Sir Joseph Fayrer in 1867, having come to nothing, Mr. L. Schwendler, of the Indian Telegraph Department, brought the subject again to the notice of the Council of the Asiatic Society in March, 1873. Mr. Schwendler proposed that the necessary capital should be raised by subscription, but that the Government of Bengal should grant the site and give a contribution towards the annual expenditure. This scheme, although taken up with interest by the Asiatic and Agricultural Societies and supported by the press, would have ended, like its predecessors, in failure, had not the energy of Mr. Schwendler led him to adopt a different course of action. Having a fine private collection of living animals of his own, Mr. Schwendler was able to prove to the Viceroy of India (then Lord Northbrook), who honoured him with a visit, how easy it was to maintain such an establishment in a climate so well adapted to animal and vegetable life as that of Calcutta. Instead of the large and expensive houses necessary in these inclement climes simple sheds suffice as a protection for the animals against the weather, and the luxuriant vegetation is ever springing up to contribute to their shelter and retirement. In fact, if only space is provided, and sufficient fencing is put up, animals can be kept almost in the same state as in their native wilds, and buildings may be dispensed with. So practical was Mr. Schwendler's illustration of how easily zoological gardens might be established in Calcutta by showing his own grounds fitted up for the purpose, that the Viceroy was convinced at once, and quickly brought the excellent Lieutenant-Governor of Bengal to a similar state of mind. Having taken up the matter, Sir Richard Temple set to work at it with his usual energy, and by a minute of September 24, 1875, granted a large site for the purpose on the road leading from Surat Bridge to the Governor's official residence at Belvedere. Shortly afterwards an honorary managing committee was appointed, with Lord Ullick Browne as president; Mr. Schwendler and Dr. King and Mr. Watson as members, and Mr. C. Buckland, private secretary to the Lieutenant-Governor, as honorary secretary. The objects of the new institution, besides the general instruction and recreation of the community, were specified to be to facilitate scientific observations on the habits of animals, to encourage their acclimatisation, and generally to promote the science of zoology. Upon the starting of the new institution, Mr. Schwendler immediately hastened to present to it his whole collection of living animals, and the Governor-General

promised to remove the Barrackpore menagerie to the new site as soon as the necessary preparations were made. All the native princes, nobility, and gentry subscribed liberally towards the proposed gardens—for instance, the Maharajah of Burdwan gave 3,000*l.*; others followed this liberal example, and the greater part of the required capital of 30,000*l.* was quickly raised. Such rapid progress was made that occasion was taken of the Prince of Wales's presence in Calcutta on December 27, 1875, to inaugurate the new institution. His Royal Highness expressed his gratification at the results already achieved, praised Mr. Schwendler for the public spirit he had displayed, and accepted the patronship of the gardens.

The Royal Zoological Gardens of Calcutta thus inaugurated were opened to the public for the first time on May 6 of last year. From that date up to the close of the year more than 50,000 persons had visited them, without including members and donors, and soldiers with their wives and children who have a free entrance. The buildings are, of course, yet far from complete, but amongst those finished are, as we are informed, many deer-paddocks, which are already well tenanted; a large and several smaller aviaries, also well filled; a large bear-house in three compartments, and furnished with a large bath; two monkey-houses, and a very large pit fitted up for the residence of rhinoceroses. Within the gardens is also a large tank or lake, with two islands used for water-fowl, and a restaurant and keepers' dwellings have likewise been erected.

At the present time Mr. C. T. Buckland, C.S., is the president of the Association for the maintenance of the gardens, and Dr. J. Anderson and Mr. H. M. Tobin have the general superintendence and honorary care of them, the paid officials consisting of natives only. A European director was appointed in January, 1876, but the Government of Bengal were shortly afterwards stopped by the Supreme Government from contributing to the expenses of the gardens, and his services had consequently to be dispensed with.

This change of front in the Supreme Government, who had virtually pledged themselves to assist in the scheme, and who have not yet redeemed their promise to transfer the Barrackpore menagerie to the new gardens, is a subject of not unnatural complaint on the part of the committee, who are now striving hard to have matters replaced upon their former footing. As the Indian Government keep up botanical gardens in Calcutta, and pay a scientific officer a liberal salary to superintend them, they would surely be fully justified in treating the Zoological Gardens in the same way, especially until the new institution is fairly set a-going. Living animals, as we all know, are far more attractive to the general public than living plants, and there can be no question, we believe, that in Calcutta, as in London, zoological gardens are more popular than botanical. The public of Calcutta have come bravely down with a sum of 30,000*l.* to set the institution going, and will be greatly disappointed if the Government do not support them. A scientific director for the establishment is an absolute necessity, as it cannot be expected that Dr. Anderson and others who now manage it can continue their gratuitous services. Lord Northbrook is now earning his well-merited repose in this country, but looking to the countenance and favour that he has already shown to the Zoological Gardens at Calcutta, we cannot doubt that he will assist in the appeal that is, we understand, now being made to the authorities at home, to obtain permission from the Government of Bengal to continue the support which it gave at first. We may also fairly call upon Lord Salisbury, who has on many occasions shown his appreciation of scientific work, to devote a few minutes' attention to this subject. It is certain that no better step could be taken for the advancement of Zoological Science in India than the establishment of the Zoological Gardens of Calcutta on a firm footing. Like our Gardens in London they might easily be made a centre whence encouragement is diffused to zoological investigations of every kind. A well-selected director, appointed and paid by the Government, would at once place matters on a satisfactory foundation, and tend to bring together support to the Institution from every quarter, and we cannot doubt that the present obstruction will be removed by the Central Authority as soon as the real facts of the case are brough before them.

OUR ASTRONOMICAL COLUMN

DOUBLE-STAR MEASURES AT CINCINNATI.—In Nos. 2 and 3 of the publications of the Cincinnati Observatory are two series of micrometrical measures of double-stars made with the 11-inch Merz refractor. The first series includes measures by Prof. O. M. Mitchell at the old Observatory, confined, with few exceptions, to the stars of the great Dorpat Catalogue, and made in the years 1846–48, a small number of which only had appeared in the *Sidereal Messenger.*—The second series comprises measures of objects situated for the most part beyond Struve's limit of south declination made in the years 1875–76, and will probably be found the most useful of the two, observations of these southern stars being as yet in small number. Mr. Ormond Stone, the present director at Cincinnati, remarks that "no systematic survey of the southern heavens similar to that made by Struve of the northern heavens has ever been undertaken," and a large proportion of Sir John Herschel's doubles have never been properly measured micrometrically. The Cincinnati object-glass having been refigured by Alvan Clark during the last winter, the director purposes devoting the instrument to supplementing the labours of other astronomers by measuring double-stars between 15° and 35° of south declination; no doubt in the course of this work new binary systems will be detected.

Amongst the stars in the second of the above series, is *h* 2036, the duplicity of which was first remarked by Sir John Herschel with the 20-feet reflector in sweep 307 (1830, Oct. 15), when the position was registered 53°·0, and the estimated distance was 2″. The last Cincinnati measures give for 1876·78, position 26°·4, distance 1″·64, and Capt. Jacob's intervening measures at Poona and Madras, confirm the retrograde motion in the angle; indeed, he first pointed out the probable binary character of the star, and also suggested another noticeable feature, viz., the apparent variability of *both* components (Mem. R.A.S., vol. xxviii. p. 41). A comparison of the whole of the estimates of magnitude to 1876, is certainly confirmatory of Capt. Jacob's suspicion. The stars have not been noted as differing more than half a magnitude, and generally have been considered of equal brightness, yet the estimations vary from 6·7 (Jacob 1857) to 9·0 (Ormond Stone, 1875). The object is well within reach in this country, and deserves watching. It may be remarked that the N.P.D. given in Sir John Herschel's fifth series of measures with the 20-feet reflector, is 1° too small. By an observation in the Washington zones, the position for the beginning of the present year is in R.A. 1h. 13m. 54·7s., N.P.D. 106° 26′ 15″.

CHANGE OF COLOUR IN α URSÆ MAJORIS.—Herr Weber continues his observations upon the colour of this star, a periodical change in which from intense fiery-red to yellow was first suspected by Dr. Klein of Cologne about fifteen years since. According to Herr Weber the change is from fiery-red to white or slightly yellowish white. The following are recent observed epochs of red light:—1876: September 5, October 10, November 14, December 21. 1877: January 16, March 23, whence an average period of thirty-three days is indicated. The star was white or nearly white, 1876: October 28, December 30. 1877: February 8 and March 13. The star is said to remain red or reddish for a shorter time than it is seen white or yellowish white. See *Astron. Nach.*, Nos. 2,111 and 2,127.

α CENTAURI.—The measures of this star which have lately appeared in NATURE show that we are yet without any satisfactory orbit, and it is much to be desired that it may be closely watched during the next few years. Mr. Gill it is understood intends to establish a good epoch in the autumn with Lord Lindsay's heliometer at Ascension. It does not appear to be too late to secure measures which will possess the greatest interest in the actual near approach of the two fine stars forming this splendid binary.

THE PRESENT COMETS.—Elements of Winnecke's comet of April 5 calculated by Dr. Plath of Hamburg, upon the same extent of observation as those of Mr. Hind, published in this column last week, are almost identical therewith, and consequently negative the idea of ellipticity of orbit, notwithstanding the certain degree of resemblance with the comets 1827 II. and 1852 II., and near equality of intervals. On May 14 the comet approaches within 10° of the pole of the equator, near the 5½ m. star, B.A.C. 1211. It will be visible with telescopic aid some weeks longer.

We subjoin positions of the comet discovered in America by Mr. Lewis Swift on April 11, and by M. Borrelly at Marseilles three nights subsequently, also calculated by Dr. Plath.

For 12h. Berlin M.T.

	R.A. h. m. s.	Decl. ° ′	Log. distance.
May 10	6 8 18	+56 7·0	0·1243
,, 12	6 27 1	54 22·5	0·1275
,, 14	6 43 53	52 30·2	0·1315
,, 16	6 59 5	50 32·1	0·1362
,, 18	7 12 46	48 30·3	0·1417
,, 20	7 25 2	46 25·9	0·1479
,, 22	7 36 11	44 21·8	0·1545
,, 24	7 46 15	+42 17·7	0·1617

M. Wolff, of the Observatory at Paris, observed the spectrum of Winnecke's comet on the morning of April 11, which he found analogous to the spectra of various comets he had observed since the year 1868, from the faintest to the brilliant comet of Coggia in the summer of 1874. All have exhibited the three bands, yellow, green, and blue, but M. Wolff remarks that the nature of this cometary matter is completely unknown. He did not succeed in obtaining the spectrum of the third comet of the present year, in which, like several other observers, he noticed a resolvable appearance.

BIOLOGICAL NOTES

ZOOLOGICAL CLASSIFICATION.—In a recent paper in *Pflüger's Archiv*, M. Hoppe-Seyler wonders at the readiness with which systematic zoology has ranked amphioxus with the vertebrates, from mere one-sided consideration of the presence of a *chorda dorsalis*, and the position of the nerve-cord above, and the alimentary canal below. A sound system groups species which are similar not merely in morphological respects, but in their whole organisation. Amphioxus has, beyond the chorda, nothing in common with vertebrates; it has no closed vascular system with red blood corpuscles, no liver which forms a gall, no proper brain, and it contains no gelatine-yielding tissue, which occurs in all vertebrates and also in the cephalopoda, but in no other invertebrata. In their entire highly-developed organism, the cephalopoda, stand nearest to the vertebrata; the amphioxus should have a place further down. M. Hoppe-Seyler further points out that comparing the composition of tissues from the lower organised animals upwards, we meet first with mucin yielding tissues, then with those yielding chondrin, then, in the cephalopoda tissues yielding glutin; the formation of actual bones does not occur in all vertebrata, and is likewise wanting in cephalopoda. Exactly the same order is seen in the stages of development of an embryo, *e.g.* of the hen in the egg, and it is difficult to think that the agreement is accidental.

LUMINOUS CAMPANULARIÆ.—The late Prof. Paolo Panceri recently made minute researches at Amalfi, near Naples, with a view to determine the exact seat of the light-giving organs in Campanulariadæ. The Gulf of Amalfi seems to be a favourite haunt of these minute animals, and Prof. Panceri found them abundantly on the algæ covering the rocks near the shore, particularly upon *Fucus ericoides*. The light of these polyps is intermittent, and only appears when the animals are touched or moved; fresh water, however, has the property of fixing it for a little time. It was principally with species of *Campanularia flexuosa* that Prof. Panceri made his interesting investigations, and the special question he wished to decide was whether it is the external cellular stratum (or ectoderm), or the internal one (endoderm) of which these animals are composed, which is the actual seat of the light. He found, by means of ingenious microscopical contrivances that the luminous movements of these polyps have their seat in the cells of the ectoderm, and not elsewhere, and that these cells alternately and successively show the light and again become dark, after being touched or placed into fresh water. Not only the bodies of the polyps, but also their slender stems and even the feet with which they adhere to the plants or rocks, contain these luminous cells. Prof. Panceri has published an account of his researches in the January part of the *Rivista Scientifico-industriale*.

RESPIRATION IN FROGS.—Mr. A. C. Horner has sent us an account of some interesting observations he has made on the spawning or deposition of ova in the frog (*Rana temporaria*). We are only able to give the conclusion of his paper:—I will now give a few facts connected with respiration which I have observed in these frogs. They can croak when they are immersed under water, but, as no air-bubbles escape, I was at first puzzled. I find, however, by holding my nose and shutting my mouth, that I can make a somewhat similar sound; but they seemed to croak louder when only the head and upper part of the body were under water than when their whole body was immersed, and as they distend their sides in the act of croaking, I thought it possible they might be able to draw in air by the rectum or the pores of their skin. When a frog out of water is touched suddenly, he shuts his eyes and distends his abdomen, and the same thing occurs when under water. Yet how is it that they can distend their abdomen without admitting more air? for they can distend it very fully, and I should think must require to expel all the air from the thoracic into the abdominal cavity. When a frog is under water, his sides sometimes pulsate rhythmically, just as when he is out of water, and about every ten seconds. Perhaps it is connected with the circulation of blood.

THE WOODPECKER.—In the April session of the German Ornithological Society Prof. Alton concluded the recital of his investigations on the habits of the woodpecker. The peculiar drumming sound often caused by it was shown on various grounds to be entirely disconnected with the search for insects as hitherto supposed, and was regarded as a call to the opposite sex. Dr. Brehm defended the woodpeckers against the charge of seriously injuring the trees, and considered the slight damages resulting from them as more than compensated by the colour and animation which they gave to the otherwise sober and quiet forests.

THE FLAMINGO.—At the same session Herr Gadow stated that by a study of the digestive organs of the flamingo he had found that it did not belong to the duck family as hitherto classified, but was to be placed among the storks, being very closely allied to the latter, although properly an intermediate link between the two families.

COPPER IN THE BLOOD.—The presence of copper in the blood of human beings and domestic animals has been placed beyond doubt by the investigations of various chemists, but has gene-

rally been regarded as an accidental circumstance due to the use of copper utensils in the preparation of food. M. S. Cloez, of Paris, recently examined the blood of a roebuck shot in the forest of Essarts, and found copper oxide present to the extent of 5½ milligrammes per kilogramme of blood. As this result would tend to show that copper is a normal constituent of the blood, the question which next awaits solution is that of the method of its entrance into the animal system.

THE RESPIRATION OF PLANTS.—We have already noticed the investigations undertaken by Prof. Borodin on the processes of respiration in plants. We find in the seventh volume of the *Memoirs* of the St. Petersburg Society of Naturalists the paper of Prof. Borodin in full, accompanied by a series of graphic representations, by means of curves, of his important measurements. We cannot attempt here to give a *résumé* either of the varied experiments made by the author or of the important questions arising from Prof. Borodin's inquiry, and discussed by him. As to the experiments themselves, we can only state that the reader will find in the paper a thorough discussion of their value and of the value of various methods used for the study of the subject. The main result is that in darkness the energy of respiration of a branch gradually decreases; a temporary action of light, however, increases it, this increase being mostly the result of the influence of the less refrangible rays (red, &c.), and it takes place only when the surrounding air can supply the plant with a sufficient amount of carbonic acid. The decrease of energy of respiration is caused by the decrease of the stock of starch in the plant, and the increase under the influence of light takes place because of the formation, under this influence, of a new stock of starch. Thus, other conditions remaining the same, the energy of respiration depends upon the existence in the branch of non-nitrogenous plastic substance; this is the material for respiration, the exhaled carbonic acid being the result of oxidation of a certain part of non-nitrogenous organic matter. While following the author in his discussion of this subject and of the opinions of Garreau, Pflüger, and Sachs, we further notice the importance of a fresh supply of oxygen in the atmosphere surrounding the plant as resulting from M. Borodin's experiments and the contributions they make to the most important and yet very obscure question as to the influence of temperature upon respiration. These important questions will be the subject of further studies, which the author proposes to continue for many years.

A TASMANIAN CARNIVOROUS PLANT.—Dr. B. Crowther, of Campbell Town, Tasmania, writing to *The Mercury* (Hobart Town), November 26, 1876, states that he was furnished with a plant which grows on rocky ground, whose crevices contain rich organic soil, different from the peaty soil Darwin's grew in. It is quite obvious, he states, on careful examination, that the plant lives to a great extent off the small flies and gnats it obtains. It is about six inches in height, and from its single vertical stem project from one to two dozen small foot-stalks, at irregular and variable distances. On the summit of each foot-stalk is a rounded disc, placed horizontally, about half an inch in circumference, fringed with tentacles of different sizes. In the centre is a hollow, with small fine filaments projecting vertically; on the ends of both the filaments and also tentacles are little reddish glands which secrete a sticky substance. The fly rests on the outer zone, is conveyed by the sticky tentacles to the centre, which at once closes upon the victim so tightly that a bulging may be seen corresponding to the fly inside. After it has been consumed, the trap again opens, showing the *débris* of the fly, which are doubtless washed away by the rain, so as to allow the trap to again set for another victim. The plant described by Dr. Crowther is evidently *Drosera peltata*, Smith, a well-known Australian species (in herbaria). It is not referred to by Mr. Darwin in his work on "Insectivorous Plants;" and any more exact information respecting its habits of life, and the mode in which it captures insects would be a very useful addition to our knowledge of these plants, especially if accompanied by drawings.

BOTANY OF NEW GUINEA.—The distinguished Italian naturalist and traveller, Dr. Beccari, has commenced the publication of a new illustrated work called "Malesia," for the purpose of bringing before the scientific world his numerous botanical discoveries in New Guinea and the Eastern Archipelago. The first number of "Malesia" has just been issued at Genoa, and is occupied with an article upon the palms of New Guinea and the adjacent islands. Fifty species of palms were collected by Dr. Beccari in these countries, many of which were previously unknown.

NOTES

MR. C. J. LAMBERT has presented to the Chemical Society 1,000*l*. and to the Royal Microscopical Society, 500*l*., from a bequest of 25,000*l*. left by his late father, to be appropriated to benevolent and scientific purposes.

WE regret to learn that Prof. M'Crady who, on the death of Prof. Agassiz, succeeded to the Chair of Zoology in Harvard College, has found it necessary to tender his resignation to the authorities of the University. This step is all the more to be lamented as judging from the terms of the resignation, which we have read, it has been caused by a desire on the part of Prof. M'Crady to raise the standard of zoological education in the college to a higher level than was deemed advisable by the authorities. We hope that some means may be found of retaining Prof. M'Crady's services to the University. He is well known as an eminent original worker in an important department of zoological research.

WE regret to announce the death of a Russian geologist, Prof. N. P. Barbot-de-Marny. Having begun his scientific work in 1852, taking part in Hoffmann's exploration of the Ural, M. de Marny continued until 1876 his valuable work of the geological exploration of Russia. He explored the Kuma-Manych depression, the provinces of Archangel, Vologda, Volhynia, Podolia, and Kherson, and all the lines of railway radiating from Moscow, as well as those of Kief, Azov, Tsaritsin, Orenburg, and Caucasus. In 1874 he took an active part in the difficult exploration of the Aral-Caspian expedition and explored the Amu-Darya. The *Mines Journal* and the *Memoirs* of the Mineralogical and Geographical Societies, as well as those of the St. Petersburg Society of Naturalists, one of the presidents of of which he was for a long time, contain about 110 of his valuable papers, besides which he was the author of some important volumes. His "Formation Stage" was an important addition to our knowledge of the Tertiary of South-eastern Europe. He died at the age of forty-five, leaving a family, a library of books many MSS., and—no money.

THE President of the Royal Academy is always very catholic in his invitations to the annual dinner, certainly one of the chief events of the London year. On Saturday last science was largely and well represented, and Dr. Hooker, in his reply to the toast of Science, happily performed what at first sight would seem a hard task under the circumstances. Dr. Hooker showed that the incongruity between art and science was only apparent; that art lends valuable aid to science, and that all true art must really be based on scientific principles; and that moreover the two have this in common, that success is unattainable in neither unless by close observation, enthusiasm, and the skilful exercise of the imagination. Some may be inclined to think that the new Grosvenor Gallery is more scientific in its method of selection

than the much maligned Academy, but then the objects of the two are very different. At all events the man of science will be furnished with much food for thought and wonder in both. What seems to be generally regarded as the masterpiece in the Grosvenor, Mr. Burne Jones's "Six Days of Creation," may remind geologists of Hugh Miller's famous phantasy, written in the old "reconciliation" days. However this may be, its conception and execution are deserving of study from many points of view, including even the scientific.

THE great Museum of Applied Sciences in Moscow will be opened on June 11, the birthday of Peter the Great. The building is ready and the collections have been brought in. It has cost up to the present time half a million of roubles, occupies a space of 13,633 square yards, and is divided into three blocks. Besides spacious rooms for collections in applied science, it contains a large and well-ventilated auditory. Eleven scientific societies will hold their sittings in the Museum.

THE foundation of a permanent station for help to wrecked vessels on Novaya Zemlya is now in way of execution. We hope that the station will also be used for taking regular meteorological observations. An Eskimo family, which has already wintered for two years on the island, will remain there permanently, and be supplied by the Russian Government with all necessaries.

PROF. LEITH ADAMS has commenced a course of six lectures on the "Distribution of Animals as elucidating Past Changes of the Earth's Surface," in the Royal College of Science, Dublin.

A PRIZE of 10*l.*, which has been placed at the disposition of the Council by Col. A. A. Croll, is offered by the Society of Arts, with the Society's Silver Medal, for the best set of Blowpipe apparatus which shall be sold retail for one guinea. All apparatus for competition must be sent to the Society's house on or before August 1, 1877. Details will be found in the *Journal* of May 4.

THE Prince of Wales, in company with Mr. Cunliffe Owen, Col. Ellis, Lord Suffield, and M. Blowitz, visited the works of the Paris International Exhibition at the Champ de Mars and Trocadero, last Saturday. He was received by M. Krantz, Director of the Exhibition, the Minister of Trade, and some officials. The Prince of Wales was much pleased with the state of the works, which are progressing so rapidly that it is now possible to have a view of the buildings covering so large a space. He selected a space for the special exhibition of objects which he brought back with him from his tour in India.

IN the current number of *Mind*, Mr. G. H. Lewes gives briefly what seems to be one of the chief positions taken by him in his new volume "The Physical Basis of Mind." He finds that according to usage the word "consciousness" is equivalent to sentience or feeling; that it is also used in a special sense as signifying that we not only feel, but feel or are conscious that we feel. Now Mr. Lewes holds that every neural process implies sensibility, indeed *is* feeling or consciousness in the general sense of that term; accordingly consciousness, sentience—these neural processes may be said to have "various modes and degrees—such as perception, ideation, emotion, volition, which may be conscious, sub-conscious, or unconscious." In the last sentence the word "unconscious" describes a mode or degree of sentience which has not given rise to consciousness in the special sense, and Mr. Lewes contends that the word "unconscious" ought to be confined to this usage, that in strictness we should not speak of unconsciousness outside the sphere of sentience. He then proceeds to argue that to describe a neural process as a mere series of physical changes is to say that "organic processes suddenly cease to be organic and become purely physical by a slight change in their *relative* position in the consensus." The matter of fact of which Mr. Lewes has to persuade his readers is, that "the reflex mechanism necessarily involves sensibility," that a neural process is a feeling.

SIX years ago Dr. Maudsley contended against the popular opinion that insanity was on the increase in this country, the rapid increase of the registered insane being open to a less gloomy explanation. It is gratifying to find that Dr. Maudsley can in the current number of the *Journal of Mental Science* still maintain with every appearance of truth, that there is no evidence of an increased production of insanity in this country.

AT a recent meeting of the Chemical Section of the Society of Arts, Dr. B. H. Paul read a paper on "The Cinchona Alkaloids, their Sources, Production, and Use," in which he traced the history of the cinchonas from the early part of the seventeenth century to their successful cultivation in India and other countries. The chemistry of the cinchona barks is a point about which but little is popularly known. It would seem that a considerable amount of cinchonidine, one of the several alkaloids found in cinchona barks, is often mixed with the sulphate of quinine of commerce, sometimes, indeed, exceeding ten per cent., and though the medicinal efficacy of the quinine is not materially impaired by this mixing, a great difference is made in the intrinsic value, cinchonidine being worth not more than one-eighth as much as quinine. Considering the present high price of quinine, it is pleasant to be told by Dr. Paul that "the sulphate of cinchonidine has been proved to be very little inferior in efficacy—for certain kinds of maladies—to quinine," the price of this alkaloid being two or three shillings an ounce against sixteen shillings for quinine.

M. JABLOSKOW, a Russian electrician, has exhibited before the Physical Society of Paris a new process for producing electric light. The voltaic arc is quite suppressed and a current is sent merely through a plate of caolin, which ignites and fuses gradually, giving out a magnificent steady light. The transverse dimension which the current is able to warm and ignite varies according to the force of the battery. M. Jabloskow made a most interesting experiment. Cutting in two parts a plate of caolin which had been used for giving a light, he raised two separate lights with the same current. The light given by these two plates was found equal to the light which had been given a few minutes previously. The experiment was considered by all present to be a great success. Experiments on a large scale will be shortly tried at the large hall of the Magazin du Louvre. The generator of electricity was an induction machine of the Alliance type worked by two men.

AT the last meeting of the Russian Geographical Society M. Wojeikof reported upon his last journey in Japan. He started from Hakodadi and visited the Aïnos of Jesso Island; he then went to Aomori, in the northern part of Nipon, and travelled to Jeddo, crossing Nipon Island three times from west to east. The northern part of the island is not populous, only the high valleys being settled. The climate of the western shores of Japan is far milder than is generally supposed, the tea-tree reaching here as far as 40° north latitude. The most important result of the journey is the measurement by barometer of the heights of about 600 places.

RUSSIAN newspapers announce that our countryman, Mr. Harvey, after having stayed for three days in St. Petersburg, continued his journey for the zoological exploration of the Pechora region. He is accompanied by a painter and a zoological collector.

THE last number of the *Isvestia* of the Russian Geographical Society announces that the south-western branch of the Society,

established at Kief, is closed by Imperial Order for political reasons.

THE same periodical gives some information as to the journey made last summer by Capt. Pevtsov with a Cossack detachment which protected the caravan with corn, sent by Russian tradesmen from the Lake Zaisan, *viâ* Bulun-Tokhoi, to the Chinese town Gu-chen (Dzungaria, N. lat. 43° 50′, E. long. 90° 14′). The results of this journey are,—a survey of the route, 560 miles long, with maps of the towns, astronomical determinations of the positions of seven points, magnetical observations, barometrical measurements of heights, a complete geological exploration along the route, a collection of about 1,000 species of plants, and a zoological collection numbering 34 mammalia and 123 birds.

THE Geological Survey of Finland, which was undertaken on the scheme of that of Sweden, but was interrupted in 1868, will be continued this year.

A TELEGRAM received by the St. Petersburg Academy of Sciences, announces that the mammoth found in the neighbourhood of Tomsk is very well preserved. A piece of its flesh with fat has been forwarded to the Academy, which, as we learn from a private source, proposes to send M. Poliakof for the exploration of the remains.

THE Russian Geographical Society has undertaken the publication of an historical sketch of geographical explorations in Northern Asia, with accounts of all expeditions, an index of works on Northern Asia, and a map showing the routes followed by all important exploring parties. The work will appear in 1879, that year being the tercentenary of the crossing of the Ural Mountains by Yermak, the conqueror of Siberia.

IN a recent communication to the Belgian Academy, M. van Monckhoven describes some improvements in the photographic reproduction of ultraviolet spectra of gases. He employs two large Geissler tubes placed parallel and communicating together by a capillary tube at right angles to them. The spectroscope consists of three 60° prisms of Iceland spar, cut so that the bisector plane of each of their dihedral angles is parallel to the optic axis of the crystal. With such prisms the ordinary and extraordinary spectra do not encroach on one another. The axis of the capillary tube is then made to coincide exactly with that of the collimator of the spectroscope, and the intensity of the light, which can be utilised during passage of the current from a Ruhmkorff coil, is found to be very much greater than if the tube were placed, as usual, perpendicularly to the axis of the apparatus. The author recommends using a plate of quartz in place of one of the large tubes of glass, so as to prevent too great absorption of rays of high refrangibility. To give an idea of the exactness with which even the most refrangible bright lines are reproduced, M. van Monckhoven presented three plates representing the solar spectrum, the bright lines of hydrogen combined with those of aluminium (of which the electrodes were formed), and the bright lines of a solar protuberance.

WE have received from Prof. E. S. Holden, of the United States Naval Observatory, a list compiled by him of the principal telescopes in the possession of public institutions and private individuals. The list, though imperfect, is a long one, and we regret that the pressure on our space prevents us from printing it. Those who would like to possess it will find it in the *Popular Science Monthly* for March. Among reflectors we notice that Lord Rosse's is still unsurpassed; it has an aperture of 6 ft. and a focal length of 55 ft. Mr. Ellery's, of Melbourne, has a 4 ft. aperture and a focal length of 32 ft.; that of the Paris Observatory an aperture of 1·20 metre and a focal length of 7 metres. Of refractors the two largest are now constructing; that for Yale College Observatory (by Clark and Sons) will have an aperture of 28 in., and the one for Vienna, constructed by Grubb, an aperture of 27 in. The refractor belonging to Mr. Newall, of Gateshead, has an aperture of 25 in. and a focal length of 29 ft.; the corresponding dimensions of the Pulkowa refractor are 14·93 in. and 270·6 in.; Lord Lindsay's, 15 in. and 15 ft.; that of Greenwich, 12·5 in. and 16·6 ft.; the largest in the Paris Observatory, 12 French in. and 5 metres; Rutherfurd's, of New York (a photographic refractor), an aperture of 10·5 French in.; Secchi, of Rome, 7·5 French in., and 14 French ft. Altogether Prof. Holden enumerates upwards of 140 telescopes that are at work on the heavens, and remarks, with some justice, that "it is a melancholy fact that the return from so many instruments is not so great as it should be, and it suggests the question as to whether future benefactors will not do better to provide astronomers to use the telescopes already constructed than observatories in which to put new ones."

To those who take a practical interest in the ventilation of houses we would recommend a pamphlet by Mr. James Curtis, C.E., entitled "Fresh Air in the House, and How to Secure It" (Ward, Lock, and Tyler). Mr. Curtis has evidently studied the important subject of ventilation carefully, and his practical suggestions will be found useful to those anxious to secure a regular supply of fresh air in their houses.

IN the note on Mr. Shrubsole's discovery (vol. xv. p. 561), the word *chalk* should be *chert*.

THE additions to the Zoological Society's Gardens during the past week include two Green-winged Doves (*Chalcophaps indica*), a Hamilton's Terrapin (*Clemmys hamiltoni*) from India, presented by Mrs. M. A. Moore; three Water Ouzels (*Cinclus aquaticus*), European, presented by Mr. G. B. Davies Cooke; an Indian Python (*Python molurus*) from India, presented by Mr. C. A. F. Bowell; six River Lampreys (*Petromyzon fluviatilis*) from British Rivers, presented by Mr. A. H. Cocks, F.Z.S.; a Virginian Deer (*Cervus virginianus*) from North America, a Rock Cavy (*Cerodon rupestris*) from South America, deposited; two Raccoon-like Dogs (*Nyctereutes procyonides*), four Common Foxes (*Canis vulpes*) born in the Gardens.

UNIVERSITY INTELLIGENCE

OXFORD.—An examination will be held at St. John's College on Tuesday, June 12, and the two following days, to elect to two Foundation Scholarships for Classics, and to the Holmes Scholarship, which will be given for Natural Science. The subjects of examination in Natural Science will be Chemistry and Physics; there will be also a pass paper in Classics; there is no restriction of age. The scholarship is tenable for five years, and is of the value of 100*l.* per annum.

The Boden Professor of Sanskrit (Mr. Monier Williams) proposes to give two public lectures (open to all members of the university and their friends) in the large lecture room of the museum, on Wednesday, May 23, and Wednesday, May 30, at three P.M. The subject will be "The Sacred Places, Religious Creeds, and Superstitions of Southern India and Ceylon," and the lectures will be illustrated by diagrams and objects of interest (including a model of the Parsee Towers of Silence) brought from India.

CAMBRIDGE.—The "Rede" Lecture will be delivered in the Senate-house on Friday, May 25, at half-past two in the afternoon. The lecturer is Sir C. Wyville Thomson, and the subject of the lecture will be "On some of the Results of the Expedition of Her Majesty's ship *Challenger*."

LONDON.—At Tuesday's Convocation of the University of London a resolution was proposed thanking the Senate for their decision to admit women to degrees in medicine. To this an amendment was moved that it was undesirable to take this course before the House had considered the advisability of admitting women to degrees in all faculties. This was carried on a division

by 142 to 129, and was afterwards adopted as a substantive motion by 144 to 116

EDINBURGH.—Lord Zetland has intimated that with the sum, amounting to between 4,000*l.* and 5,000*l.*, which he has received as compensation for the abolition of patronage in Orkney and Shetland, he intends to found several bursaries in connection with the Faculty of Arts in Edinburgh University. His lordship, in so disposing of the money, has in view the advancement of the educational interests of Orkney and Shetland, of either of which the intending bursars must be natives.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, April 12.—"On the Constant Vibration of Minute Bubbles." By Walter Noel Hartley, F.R.S.E., King's College, London.

Those who have given great attention to the study of fluid cavities in minerals, have occasionally met with vibrating particles which are apparently bubbles.

Mr. Hartley became acquainted with these at the close of last year, 1875, when Mr. P. J. Butler showed him a ruby containing a cavity partially filled with liquid carbonic acid, the bubble in which, when of small size, was in constant motion.

He also refers to a felstone containing portions of quartz with many cavities. The majority of these were water cavities, but others appeared to be empty; and in one of them Mr. Young had noticed a moving particle, supposed to be a bubble, which made its appearance only in a cold atmosphere. By dropping a little ether on the object, the evaporation cooled it sufficiently to condense a liquid in the cavity, and the moving particle was easily seen with a magnifying power of 400 diameters. By immersion in iced water, the temperature of which was 3°·5 C., the cavity had the appearance of being two-thirds filled with a liquid, the gas-bubble of course occupying the remaining space, and having a sort of trembling motion. The bubble decreased in size, and the motion became more and more rapid as the size became smaller, until it rushed up and down and across the space in which it was confined. The thought immediately occurred that this was not a gas-bubble, but a liquid in the spheroidal condition,—in all probability carbon dioxide in a perfectly dry condition, and perhaps mixed with some incondensable gas, so that its critical point was lowered.

He concludes:—I have proved that gas-bubbles in water as well as in carbonic acid, may be attracted by a source of heat giving an extremely slight rise of temperature. It is impossible to imagine a body which is not gaining or losing, or at the same time both gaining and losing heat; it is therefore impossible to imagine it entirely throughout at a uniform temperature. It is evident then that an easily movable particle which can be set in motion by exceedingly slight rises of temperature will make the transference of heat from one point to another plainly visible; I have shown that the minute bubbles in fluid-cavities are such particles; and I believe that the vibratory motions which I have described afford an ocular demonstration of the continual passage of heat through solid substances. These phenomena really make the molecular vibrations of matter plainly visible.

April 12.—"On Attraction and Repulsion of Bubbles by Heat," by Walter Noel Hartley, F.R.S.E., F.C.S., King's College, London.

The paper deals with the bubbles in fluid-cavities of crystals, and their behaviour when a source of heat is brought near them.

With regard to the attraction of bubbles by heat, the author has noticed this take place in some water-cavities when the bubbles were free to move, and no carbonic acid was present.

With regard to this second point, the repulsion of bubbles by heat, water being the only liquid. It occurs quite as frequently, if, indeed, not more so, in the specimens which the author has examined, than attraction; and it is seen to occur in cavities containing water and liquid carbonic acid.

In a paper which the author lately communicated to the Chemical Society, he has given details of experiments on certain bubbles in water-cavities, which prove that by rise of temperature the bubbles become denser than the water and sink.

Bubbles attracted by heat and those which are repelled have generally been found in separate and entirely different specimens, and it would appear most improbable that they should exist in the same piece of stone side by side.

My work, the author said, was discontinued for a long period of two months, but on being able to look over my specimens once more, I verified all my former observations, and became surprised by the following discovery:—A bubble which was repelled by a gentle heat was attracted after it had been heated more strongly, and then on cooling it was again repelled. It appeared to contain some liquid carbonic acid floating on water with the gas.

It may be considered an argument against the motions being due to any pyro-electric conditions of the minerals, that they have been noticed in crystals of fluor-spar, and that no matter in which direction sections of rock-crystal are cut, the movements are all equally well obtained.

Regarding the repulsion of gas-bubbles, two facts are striking, namely, the very slight rise of temperature (less than ¼° C.) on one side of the bubble capable of causing the movement, and the great tension existing within the bubble. The gaseous contents prevent attraction by resisting the repulsion of the liquid from the wall of the cavity. Warmth at one side of the bubble results in increased tension of the gas. This being partial, causes such internal molecular disturbance before it becomes uniformly distributed, that the bubble is rolled away from the source of heat. The bubble then takes up that position consistent with the least internal pressure. In this case it is the same bubble which moves from end to end of the cavity. When repulsion is followed on rise of temperature by attraction, the *modus operandi* is the following:—Repulsion due to the circumstances above mentioned occurs until such a temperature has been reached that, in spite of the presence of gas within the bubbles, the increased vapour-tension of water becomes a motive power by reason of evaporation and condensation, the motion of course being in the reverse direction.

April 19.—"On some Figures exhibiting the Motion of Vibrating Bodies, and on a New Method for Determining the Speed of Machines," by Herbert M'Leod, F.C.S., Professor of Experimental Science, and George Sydenham Clarke, Lieut. R.E., Instructor in Geometrical Drawing in the Royal Indian Engineering College, Cooper's Hill. [See Physical Society.]

Chemical Society, May 3.—Dr. Gladstone in the chair.—The treasurer announced that 1,000*l.* had been placed to the credit of the Society by the son of the late fellow, Mr. Lambert.—The following papers were read:—On some points in gas analysis, by J. W. Thomas. The author finds that nitric oxide is absorbed by caustic potash and pyrogallic acid, and recommends that a known volume of pure oxygen should be introduced after the absorption of carbonic acid and any decrease of volume noted as nitric oxide. He states that an excess of caustic potash should always be present in the alkaline pyrogallate, but that too much of the latter should not be used.—On the decomposition of nitric oxide by pyrogallate of potash, by Dr. Russell and W. Lapraik. The authors state the probable action of the above reagent is to convert nitric oxide into half its volume of nitrous oxide, but simultaneously another more obscure reaction takes place, so that 58 to 76 per cent. of the gas is absorbed instead of 50 per cent.—Contributions to the history of the naphthalene series. No. 1. Nitroso-β-naphthol, by Dr. Stenhouse and Mr. Groves. Nitroso-β-naphthol was obtained by the action of nitrosyl sulphate on β-naphthol and purified by conversion into a barium compound, &c.; it crystallises in brilliant hydrated yellow needles or anhydrous orange brown plates or prisms. It melts at 109°·5 C. By treatment with dilute nitric acid mononitro-β-naphthol is obtained. By acting on the barium compound of nitroso-β-naphthol with hydrogen sulphide a precipitate is formed which, by the action of potassium dichromate, is converted into β-naphthaquinone melting at 96° C.; this substance is interesting as being the first instance of two isomeric quinones derived from the same hydrocarbon.—On asbestos cardboard and its uses in the laboratory, by W. N. Hartley. This substance resembles thick greyish cardboard and is formed principally of asbestos fibres; it can be cut or moulded (by moistening with water) into any shape, and is extremely useful for crucible supports, muffles, &c.

Zoological Society, May 1.—Prof. Newton, F.R.S., vice-president in the chair.—Mr. Howard Saunders exhibited and made remarks on some nests and eggs of the Orphean Warbler (*Sylvia orpheus*) from the vicinity of Malaga, Spain. Amongst the eggs in each nest were one or two of larger size, supposed to

be possibly the eggs of the Cuckoo. Mr. Howard Saunders also exhibited two skins of Dupont's Lark (*Certhilauda duponti*) from the same locality.—Prof. St. George Mivart read a paper on the axial skeleton of the Pelicanidæ, selecting *Pelicanus* as his type and standard of comparison. Prof. Mivart first compared it, as regards its axial skeleton, with *Struthio*, and the other *Struthionidæ*, and then compared the other *Steganopodes* with it and with one another.—A communication was read from Dr. M. Watson, Professor of Anatomy, Owens College, Manchester, on the anatomy of *Hyæna crocuta*, in which he described the very peculiar conformation of the female generative organs of that animal.—Mr. A. G. Butler read a paper wherein he gave the description of two small collections of Heterocerous Lepidoptera from New Zealand, recently brought to England by Dr. Hector and Mr. J. D. Enys.—A communication was read from Dr. O. Finsch giving an account of a small collection of birds from the Marquesas Islands. Amongst these were three examples of a new species of Kingfisher, proposed to be called *Halcyon godeffroyi*.—A communication from Mr. Frederick Smith contained descriptions of four new species of Ichneumonidæ in the collection of the British Museum. Amongst these was a new *Bracon*, remarkable for having its ovi-positor more than nine times the length of its body. This was proposed to be called *Bracon penetratror*, and had been received from Yokohama, Japan.—Prof. A. H. Garrod read some notes on the anatomy and systematic position of the genera *Thincorus* and *Attagis*, which he considered should be referred to the Limicolæ in the neighbourhood of *Glareola* and *Cursorius*.

Geological Society, April 25.—Prof. P. Martin Duncan, F.R.S., president, in the chair.—Messrs. S. Bewsher, H. G. Bolam, Charles Thomas, and John M'Kenzie Knight were elected fellows of the Society.—On the upper limit of the essentially marine beds of the Carboniferous system, and the necessity for the establishment of a "Middle Carboniferous Group," by Prof. E. Hull, F.R.S. The author, in this paper, divided the whole of the Carboniferous rocks into successive stages from A to G inclusive, taking the Carboniferous beds of Lancashire as a type, and showed that these stages could be identified over the whole of the British Isles. It was only recently that their determination had been made in Ireland, so that until now the materials had not existed for a complete correlation of the series in the British Islands. The following is an abbreviated statement of the representative stages in descending order:

Essentially Freshwater or Estuarine, with one or two Marine Bands.

STAGE G.—*Upper Coal-measures* of Lancashire (2,000 feet) and other English coal-fields. Red Sandstones, &c., of Bothwell and Ayr, in Scotland. (Absent in Ireland.)

STAGE F.—*Middle Coal-measures* of Lancashire, &c., with principal coal-seams (3,000 feet). "Flat coal-series" of Scotland. Present in Ireland (Tyrone, Kilkenny).

Essentially Marine.

STAGE E.—"*Gannister Beds*" (Phillips), with marine shells and thin coals (2,000 feet), in Lancashire. "Pennystone series" of Coalbrook Dale, South Wales, &c. "Slaty black-band" series of Scotland. (Present in Ireland, Kilkenny, Dungannon, Lough Allen coal-fields.) Also in Belgium, Rhenish Provinces, and Silesia, with numerous marine shells.

STAGE D.—*Millstone Grit Series* of England and Wales, 3,500 feet in Lancashire; "Moorstone Rock" of Scotland; "Flagstone-series" of Carlow and Kilkenny; Millstone-grit of Fermanagh and Leitrim, with coals and marine shells.

STAGE C.—*Yoredale Beds*. 3,000 feet in Lancashire; Upper Limestones and "Lower Coal and Ironstone series" of Scotland; Shale series of Kilkenny and Carlow; Ironstone shales of Lough Allen, with marine shells.

STAGE B.—*Carboniferous Limestone*. Mountain Limestone of Derbyshire; "Scaur Limestone" in Yorkshire; "Lower Limestone" (Roman camp) of Scotland; Carboniferous Limestone of Ireland.

STAGE A.—*Lower Limestone Shale* of England. Calciferous Sandstone series ("Tuedian," Tate) of north of England and Scotland; Lower Carboniferous Sandstone, north of Ireland; Lower Carboniferous slate, with Coomhola grits, with marine shells, south of Ireland. (In Scotland, estuarine or lacustrine.)

Palæontological Results.—On making a census of the Molluscan and other fossils from the various stages above that of the Carboniferous limestone (stage B) as determined by the palæontologist of the Geological Survey, some interesting results were obtained, showing the prevalence of marine conditions up into stage E, and a general change in the character of the fauna in the succeeding stages. Including only the area of the British Islands, it was found that no fewer than thirty-seven genera, with seventy-four or seventy-five species, of decidedly marine forms, occur in the Gannister beds (stage E), of which all the genera and about forty species were known in the stage of the Carboniferous Limestone. The series includes *Phillipsia*, which has been found by Dr. F. Römer, in the representatives of stage E in Silesia. On the other hand, of the whole number of species in stage E (Gannister beds), only six are known in the overlying stages F and G, these being characterised by the prevalence of bivalves of supposed lacustrine or estuarine habitats, variously called *Unio* and *Anthracosia*. Of the few species of marine genera known in stage F (Middle Coal-measures), about five or six species are peculiar to itself, according to the determination of the late Mr. Salter. Such a remarkable difference in the fauna of the Upper and Middle Coal-measures, as compared with that of the Gannister beds, constituted, in the author's opinion, sufficient grounds for drawing a divisional line between these two divisions of the Carboniferous series. Of the several existing methods of classification adopted by different authors, none of them appeared sufficiently to recognise the palæontological distinctions and characteristics of the several formations. The large number of genera and species which are now known to range up from the Carboniferous Limestone into the Gannister beds, and no higher, indicated the proper horizon for a divisional line, in fact a palæontological break at the top of the Gannister beds. On the other hand, the mineral and palæontological differences between the Carboniferous Limestone and the overlying Yoredale series were sufficient to justify their separation into distinct divisions; while the Yoredale, Millstone-grit, and Gannister series are related by close mineral and palæontological resemblances. With a view, therefore, of bringing the classification of the Carboniferous series into harmony with the character of the representative faunas, and the physical features of the successive stages, the author suggests that stages C, D, and E, composed of essentially marine beds, should be united into a Middle Carboniferous group; while stages F and G would remain as at present, in the Upper Carboniferous, their fauna being essentially of fresh water. In the discussion which followed, Professors Ramsay, Boyd-Dawkins, Prestwich, and Hughes seemed to doubt the feasibility of permanently maintaining the lines of demarcation laid down in the paper.—On coal-pebbles and their derivation, by H. K. Jordan, F.G.S.

Physical Society, April 28.—Prof. G. C. Foster, president, in the chair.—Mr. W. Ackroyd described some methods of studying selective absorption in relation to the doctrine of aggregation. After referring to the absorption of iodine vapour and iodine violet solutions he showed that an analogy exists between these solutions and the aniline dyes, and a method was indicated by which the approximate size of the particles affecting light might be estimated.—Prof. H. McLeod exhibited several forms of apparatus which he has, in conjunction with Lieut. G. S. Clarke, R.E., arranged for determining the speed of machinery, &c., from observations made on the figures produced by combining their motion with that of a vibrating body; a description of them has already been communicated to the Royal Society. If a uniformly-moving point of light be reflected from a mirror attached to a tuning-fork vibrating in a plane at right-angles to the motion of the point, the reflected image will appear as an ordinary single wave, and a double figure of the form of a series of figures of eight, caused by the overlapping of two waves, will be formed if a series of points of light move uniformly with such a velocity that a point passes over two intervals during an odd number of vibrations of the fork. If equidistant perforations be made in a circle on a disc which is attached to a rotating axis and the number of vibrations of the fork be known, the form of figure reflected on to the screen will, theoretically, give the requisite data for determining the rate of rotation of the disc, and further, a slight increase or decrease in this rate causes the figure slowly to move in the same or opposite direction to the disc. If the fork make 3,600 vibrations and the disc 100 revolutions per minute, the circle must be divided into seventy-two equal intervals, but for such a number as 101 revolutions 71·287 intervals are needed. This fact would introduce some difficulty in preparing an apparatus for measuring the velocity of rotation so as to give the speed in whole numbers per minute, but it may be obviated by ruling convergent white lines on dark paper and so

wrapping it round a cylinder that one line is parallel to the axis, an arrangement which gives every possible subdivision of a circle between any given intervals. The figures are then observed by examining these lines through a narrow slit in a light opaque screen attached to a tuning-fork or reed vibrating in a plane parallel to the axis of the cylinder. This observing apparatus is moved parallel to that axis until the figure remains stationary, when the number of rotations is read off on a graduated scale. Conversely, if the number of rotations of the cylinder is known, the period of the tuning-fork can be determined. Incidentally Prof. McLeod explained a simple method of causing a fork to vibrate, and the manner in which they have succeeded in maintaining the vibrations of a reed. It was found that variations in temperature influence the determinations, inasmuch as they cause the period of the fork or reed to vary. When the former is used it becomes necessary to deduct 0·011 per cent. of the result for each degree centigrade of rise above the temperature for which the fork is set, and 0·0277 per cent. when employing a reed.

Anthropological Institute, April 24.—Mr. John Evans, F.R.S., president, in the chair.—Dr. John Rae read a paper on the migrations of the Esquimaux. The chief subjects of Dr. Rae's remarks were two papers read before the Ethnological Society, twelve years ago, the one by himself, the other by Mr. Clements R. Markham. Dr. Rae considered that Mr. Markham's present view was in accordance with what he (Dr. Rae) advanced in 1865, viz., that the route of the Eskimo must have been along the coast of America, across the Strait (northward) to Banksland, and thence to the Parry Islands, &c., where so many traces of them remain. He gave some information regarding various peculiarities of the Eskimos, and exhibited a stone lamp, with a curiously-shaped piece of stone, used for adjusting the wick, which consists of a species of fibrous moss (sphagnum) brought with the lamp from Repulse Bay more than twenty years ago. The lamp when lit gave a clear bright flame, from each of the three bits of moss used, without any perceptible smoke. These form valuable articles of barter by the Eskimos in the neighbourhood of such localities, with the more distant natives, for they seem to be in almost universal use, from Behring Strait eastward to Hudson Bay.—Mr. Robert B. Holt then read a paper on earthworks in Ohio, and Prof. Busk, F.R.S., described some skulls from the same place.—The following gentlemen took part in the discussions:—Mr. Hyde Clarke, Mr. Allen, the president, and others.

PARIS

Academy of Sciences, April 30.—M. Peligot in the chair.—The following papers were read:—On a phenomenon of insolation of the eye, which has not hitherto been explained, by M. Chevreul. A few days before St. Bartholomew's day the Prince de Navarre (afterwards Henri IV.) being with the Duc d'Alençon and the Duc de Guise, at the Louvre, playing dice, they twice saw blood spots on the dice, whereupon they separated, in alarm. M. Chevreul explains the phenomenon as an effect of contrast of colours in sunlight, and gives some experiments in illustration. Material black appears red in reflecting white light.—On carbuncular disease, by MM. Pasteur and Joubert. Are the effects due to the bacteridium or to a virus? The bacteridium may be multiplied indefinitely in artificial liquids, without losing its action on the system, so we cannot suppose it accompanied with a soluble substance (or virus) producing, jointly with it, the carbuncular effects.—Probable consequences of the mechanical theory of heat, by M. Favé. He seeks to explain the phenomena attributed by M. Boutigny to the "spheroidal state," by supposing that the calorific waves of the sidereal ether have a repulsive action on ponderable matter. Take the case of a little water poured into a red-hot capsule. The heated metal gives radiant heat, *i.e.*, impresses the ether with waves which are rapidly propagated. This motion upwards counterbalances that due to the weight of the water. The distance between liquid and metal depends on the *vis viva* developed by the ether. The motion of oscillation is combined with one of varying rotation due to the resultant of the repulsive forces not passing through the centre of gravity of the globule.—On a new deposit of liquid mercury, indicated in the upper valley of l'Herault by M. de Quatrefages, by M. Leymerie.—On a new Arctic expedition of M. Nordenskjöld, by M. de Saporta. He intends prolonging his exploration as far as Behring Straits. The expedition is to leave Sweden in the summer of 1878.—Electro-silicic light, by M. Planté. He calls attention to the bright light produced when one or other electrode of his secondary batteries is applied to a tube or plate of glass. The glass is decomposed, and the luminous effect is probably due to incandescence of the silicium.—On a process of solidification of sulphide of carbon, by M. Mercier. Treating oils with a little protochloride of sulphur, a transparent solid matter is got, with nearly the elasticity of caoutchouc. If a volatile liquid be added at the moment of mixture, as benzine, oil of petroleum, or sulphide of carbon, the solidification takes place all the same, and the volatile liquid is imprisoned as in a net-work, from which it can only escape slowly. The mixture may hold even 70 per cent. of sulphide of carbon.—On the treatment of phylloxerised vines with sulpho-carbonate of potash, by M. Fatio.—On the rooting out of phylloxerised vines, by M. Cornu.—On the comparative structure of the roots of American and indigenous vines, and on the lesions produced by the phylloxera, by M. Foëz.—On the regeneration of phylloxerised vine-stocks by the employment of sulpho-carbonate of potash, by M. Gueyrand.—M. Dumas presented the first document from a Commission charged by the Emperor of Brazil, to determine the geographical positions of the principal points of the empire. It treats of the position of Barra do Pirahy, relatively to Rio de Janeiro Observatory.—Observations of Comets II. (Winnecke) and III. (Swift, Borrelly), by M. Wolf.—On some observations of solar spots, by M. Denza. This confirms M. Janssen's observations.—On the surfaces whose principal radii of curvature are functions of each other, by M. Mannheim.—Investigation of the law which a central force must follow for the trajectory which it produces to be always a conic, by M. Darboux.—On the laws of Kepler; solution of a problem proposed by M. Bertrand, by M. Halphen.—Reply to a note of M. Kirchhoff on the theory of elastic plates, by M. Levy.—Singular solutions presented in the problem of curvilinear motion of a point under the action of a central force, by M. Boussinesq.—On substances capable of being produced at a temperature above that which causes their complete decomposition, by MM. Troost and Hautefeuille. Examples are: protoxide of silver, ozone, protochloride of platinum, sesquichloride, protochloride, and subfluoride of silicium.—Process of industrial preparation of pure salts of alumina, by M. Ducla.—On monochlorised acetones, by M. Etard.—Experiments proving that the septicity of putrefied blood is due to figured ferments, by M. Feltz.—On the fixation of tannin by vegetable tissues, by M. Müntz. The tissue of champignons, especially, may be "tanned" into a kind of vegetable leather.—On gaseous exchanges between plants and the atmosphere; reply to critical observations of M. Barthelemy, by M. Merget.—Researches on the absorption and emission of gases by roots, by MM. Deherain and Vesque.—On the spontaneous and regular movements of a submerged aquatic plant, *Ceratophyllum demersum*, by M. Rodier.—On the presence of mercury in the springs of Rocher (Puy-de-Dôme), by M. Garrigon.—On a case of hereditary hemiteria, by M. Martinet.—On increase of the production of springs, by M. Chefdebien.

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